

CLAIMS

We claim:

1. A semiconductor substrate comprising at least two layers of different material in which each layer has a different thermal expansion coefficient.
- 5 2. The semiconductor substrate of claim 1 wherein the material of one of the layers is selected from the group consisting of sapphire, silicon, silicon carbide, zinc oxide, gallium arsenide, gallium phosphide, indium phosphide,  $\text{LiGaO}_2$ , and  $\text{LiAlO}_2$ .
- 10 3. A flat epitaxial wafer, comprising an epitaxial layer on a layered substrate wherein the substrate comprises at least two layers of different material in which each layer in the substrate has a different thermal expansion coefficient.
- 15 4. The flat epitaxial wafer of claim 3 wherein the substrate comprises two layers and the top layer attached to the epitaxial layer has a larger thermal expansion coefficient than both the epitaxial layer and the bottom layer of the substrate.
- 20 5. The flat epitaxial wafer of claim 3 wherein the substrate comprises two layers and the top layer attached to the epitaxial layer has a smaller thermal expansion coefficient than both the epitaxial layer and the bottom layer of the substrate.
- 25 6. The flat epitaxial wafer of claim 3 wherein the epitaxial layer comprises a III-V nitrides alloy and the material of the top layer is selected from the group consisting of sapphire, silicon, silicon carbide, zinc oxide, gallium arsenide, gallium phosphide, indium phosphide,  $\text{LiGaO}_2$ , and  $\text{LiAlO}_2$ .
- 30 7. The flat epitaxial wafer of claim 3 wherein the epitaxial layer comprises a III-V nitrides alloy and the substrate is a material selected from the group consisting of sapphire on silicon, sapphire on a III-V nitrides, sapphire on zinc oxide, and sapphire on silicon carbide.

8. A semiconductor device comprising a device layer on a layered substrate, wherein the layered substrate comprises at least two layers, wherein at least two layers have different thermal expansion coefficients.

5 9. The semiconductor device of claim 8 wherein the device layer comprises a III-V nitrides alloy and the material of the top layer of the substrate is selected from the group consisting of sapphire, silicon, silicon carbide, zinc oxide, gallium arsenide, gallium phosphide, indium phosphide, LiGaO<sub>2</sub>, and LiAlO<sub>2</sub>.

10 10. The semiconductor device of claim 8 wherein the device layer comprises a III-V nitrides alloy and the substrate is selected from the group consisting of sapphire on silicon, sapphire on a III-V nitrides alloy, sapphire on zinc oxide, and sapphire on silicon carbide.

15 11. An epitaxial growth method comprising:  
growing an epitaxial layer on a layered substrate, wherein the layered substrate has at least two layers, wherein at least two of the layers have different thermal coefficients;  
and  
removing the layered substrate after growing the epitaxial layer.

20 12. The epitaxial growth method of claim 11 wherein removing comprises selective etching of a top layer of the layered substrate.

25 13. The epitaxial growth method of claim 11 wherein the epitaxial layer comprises a III-V nitrides alloy and the material of the top layer of the layered substrate is selected from the group consisting of sapphire, silicon, silicon carbide, zinc oxide, gallium arsenide, gallium phosphide, indium phosphide, LiGaO<sub>2</sub>, and LiAlO<sub>2</sub>.

30 14. The epitaxial growth method of claim 11 wherein the epitaxial layer comprises a III-V nitrides alloy and the substrate is selected from the group consisting of sapphire on silicon, sapphire on a III-V nitrides alloy, sapphire on zinc oxide, and sapphire on silicon carbide.

15. An epitaxial growth method comprising:  
growing an epitaxial layer on a first side of a substrate at an elevated temperature; and  
without cooling down to room temperature, growing an epitaxial layer on  
5 an opposing side of the substrate.
16. The epitaxial growth method of claim 15 wherein the epitaxial layer grown on the first side of the substrate and the epitaxial layer grown on the opposing side of the substrate are grown simultaneously.
- 10 17. The epitaxial growth method of claim 15 wherein the substrate is sapphire and the epitaxial layer grown on one side comprises a III-V nitrides alloy, and the layer grown on the opposing side of the substrate is selected from the group consisting of silicon, zinc oxide, silicon carbide, and a III-V nitrides alloy.
- 15 18. An epitaxial growth method comprising directly heating a layered substrate by a radiation source without any heat sink material, wherein each layer of the layered substrate has a different thermal expansion coefficient.
- 20 19. An epitaxial growth method comprising:  
placing a substrate in a system so that each side of the substrate is not completely covered by any parts or susceptor blocks;  
supplying a set of reactant species on one side of the substrate;  
supplying another set of reactant species on the other side of the substrate;  
25 and  
preventing mixing of the two sets of reactant species.
20. The epitaxial growth method of claim 19 wherein the preventing comprises preventing the mixing of the two sets of reactant species with a physical partition.
- 30 21. The epitaxial growth method of claim 19 wherein the preventing comprises preventing the mixing of the two sets of reactant species with inert gas flows.

22. The epitaxial growth method of claim 19 wherein both sets of reactant species comprise a nitrogen source and a group-III metal source.

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23. The epitaxial growth method of claim 19 wherein one set of the reactant species comprises a nitrogen source and a group-III metal source and the other set of reactant species comprises a silicon source.

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